CHAPTER X: ORIGINS OF OHIO RIVER CANALIZATION, 1870-1910

The construction of a lock and dam, canalization project on the Ohio River was first recommended by William Milnor Roberts and other engineers a decade before the Civil War; and Roberts, as Superintendent of Ohio River Improvements, reiterated his recommendation in 1870. Though open-channel improvement of the Ohio was to continue until the completion of the slackwater project, the major development of interest on the Ohio in the late nineteenth and early twentieth century was the Ohio River Canalization Project. Construction of the canalization project began, under the direction of Colonel William E. Merrill, at Davis Island Lock and Dam (No. 1) just below Pittsburgh in 1878. The basic engineering-construction methods and structural features of the project to provide a dependable navigable depth on the Ohio River were first devised, constructed, and tested at Davis Island. The Davis Island project opened to navigation in 1885, and after it had been operated successfully for several years additional locks and dams were constructed to provide a six-foot minimum depth on the Upper Ohio. And in 1910 Congress authorized a project to provide a nine-foot navigable depth throughout the length of the Ohio River.

During this period, 1870-1910, the only permanent navigation structure on the Lower Ohio was the canal and dam at Louisville, and the authorized project for that river section was a continuation of the time-honored methods of channel clearance, excavation, and dike construction. But the history of the development of the Ohio River Canalization Project on the Upper Ohio is also important in understanding the history of the Louisville Engineer District, for the project on the upper river set the pattern for the work of the Louisville District after 1910. In addition, personnel of the Louisville District were also involved in the early planning and construction of the canalization project.

The down river progress of the canalization project on the Ohio prior to 1910 was slow, agonizingly so to navigation and commercial interests in the Ohio Valley, for "pork-barrel" federal waterways policies of the era limited the funds available for the Ohio River. And the Army Engineers proceeded cautiously, testing theories against experience, modifying the project as technological advances, actual operations, and waterborne commerce development proved necessary, convincing skeptics who questioned both the practicability and advisability of the project, and conciliating conflicting waterways and political interests. Though slackwater projects had been completed on tributaries of the Ohio and though European waterways engineers had developed movable dams, there were actually no precedents for the slackwater improvement of a stream the length and breadth of the Ohio.

The Roberts Survey, 1867-1870

It will be recalled that W. Milnor Roberts was appointed Superintendent of Ohio River Improvements in 1866 and that he made a preliminary examination of the river in that year. In 1867 he commenced a detailed survey of the river, beginning work where the Sanders survey had ended (271 miles below Pittsburgh) in 1844. Two survey parties, under Alonzo Livermore, former project engineer on the Green and Barren rivers, and Sigismund Low, an experienced railroad construction

engineer, descended the river in flatboats, while Roberts, his son Thomas P. Roberts, and Captain George Rowley traveled the river in the steamboat *Major Sanders* surveying shoals for dike construction. Though the survey parties suffered terribly from malarial fevers, the survey was completed in 1869, furnishing the first complete and accurate information about the hydrology of the entire river on 118 hand-drawn charts.[1]

During the course of the survey, Roberts noted that beacon lights were urgently needed to guide navigation through the narrow, rocky channel at Grand Chain on the Lower Ohio, and he officially recommended to Congress that they be provided. The United States Lighthouse Service had been established by Congress in 1852, but its activities were limited to coastal and Great Lakes harbors. Prior to 1869, boat pilots on the inland rivers depended upon recognition of topographic features — bluffs, tall trees, farm houses, and so forth — as a guide to channel location. No action was immediately taken on Roberts' recommendation, and the Louisville Pilots Association acted independently, in October, 1869, placing oil lamps on the Illinois bank at the head and foot of the Grand Chain, which were probably the first beacons for navigation on the inland rivers. At continued urging of the Corps and the river interests, the functions of the Lighthouse Service were extended to the inland rivers in 1874. It installed about 150 beacons and buoys on the Ohio River in 1875.[2]

Renewed Improvement of the Ohio, 1867-1870

While completing the detailed survey of the Ohio, Milnor Roberts had two other duties to perform: removal of all movable obstructions from the channel and construction of dikes at points most likely to benefit low-water navigation. He entered into contract with several firms for repair and construction of dikes, and contracted in 1867 with Commander John Rodgers, owner of the wrecking steamer *Greenback*, for removal of snags and wrecks. In 1868 he also chartered two additional wrecking boats, the *Zebra* and *Petrolia*. The character of open-river improvements had not changed significantly since the days of Captain Shreve, as the report of the operations of the *Petrolia* at Hurricane Island above Paducah, Kentucky, in July, 1868, indicated:

> We arrived at this place in good season. There were one hundred snags in the water here, all with their ends in sight above water; they are deeply imbedded in the sand and mud; unfortunately the river is raising again . . . and we may not be able to reach all. We will take out fifty of the worst snags here, and cut them up on the river bank, if the water permits. The snags are all very heavy, and have to be cut up into short pieces and taken to the bank . . . The average size of the snags is from 2½ to 5 feet through at the butt, and from 60 to 120 feet in length, and are mostly tough wood . . . One that we took out, a monster pecan, was 5 feet in diameter and 120 feet in length. We worked at this snag four days, it being solid as mahogany, breaking chains and wearing out saws, but we succeeded in getting entirely rid of it.[3]

Milnor Roberts accepted a position as chief construction engineer at Eads Bridge across the Mississippi at St. Louis in 1870. He later surveyed routes across the Rockies as Chief Engineer of the Northern Pacific Railroad, served as president of the American Society of Civil Engineers, and, at his death in 1881, was chief engineer of all rivers and harbors projects in Brazil. Before departing the Ohio River, he completed an analysis of commercial and hydrologic data and officially recommended the adoption of a canalization project to provide reliable navigable depths.[4]

COLONEL WILLIAM E. MERRILL

Cincinnati and Pittsburgh District Engineer 1870-1891

Louisville District Engineer 1884-1886

Colonel William E. Merrill, Corps of Engineers, assumed charge of Ohio River Improvements, except for the Falls and Louisville canal, on June 17, 1870. Colonel Merrill, the son of an officer who died in action during the Mexican War, had received his early education at Louisville. As a cadet at West Point — he graduated first in the Class of 1859 — he received the nickname "Padre" because of his fondness for foreign languages and his high standards of personal integrity. (It will be recalled that he resigned as Louisville District Engineer in 1886 rather than submit to political interference.) "Padre" Merrill had directed military construction and combat engineering in the Ohio Valley during the Civil War, and had served on General Sherman's staff until appointment to the Ohio River project. In 1871, after Colonel John N. Macomb and the Office of Western River Improvements transferred from Cincinnati to St. Louis, Colonel Merrill moved the Office of Ohio River Improvements from Pittsburgh to Cincinnati, where supervision of work on the Ohio would be more centrally-located.[5]

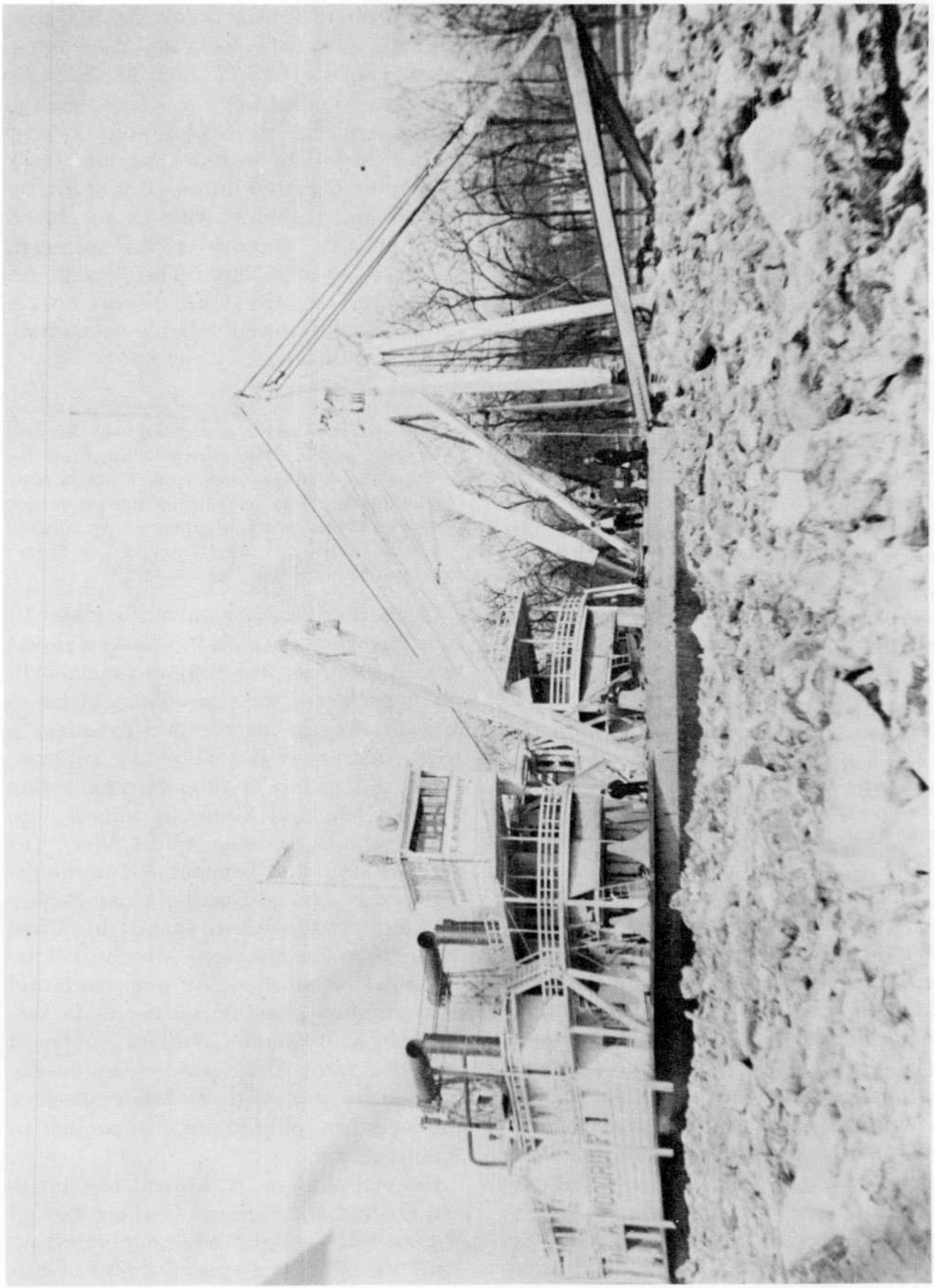
Most work on the Ohio under the direction of Roberts at Pittsburgh had been concentrated on the Upper Ohio. Merrill extended operations to the lower river, contracting for such work as the repair of Cumberland Dam at Smithland and the removal of Baccus Rock, Jackson Rock, and other obstructions at the Grand Chain. He also concluded that the contracting wrecking steamers were unsatisfactory, as the four days taken by the *Petrolia* to remove a simgle snag perhaps proved, and initiated construction of an Engineer floating plant for use exclusively on the Ohio.[6]

New Floating Plant, 1870-1876

Colonel Merrill and his staff studied inland river watercraft, concluded that wooden hulls were not sufficiently durable for the hard-service of river improvement, and arranged the construction of a snagboat with an iron hull. Merrill believed an iron hull might last as long as fifty years; whereas, wooden hulls were seldom useful after ten-years service. A few iron-hulled vessels had been constructed for private concerns prior to 1870, but the advantages of such hulls were not generally understood.

The iron-hulled snagboat *E. A. Woodruff* was built at Covington, Kentucky, in 1875. It had a wide, flat-bottomed hull with a broad stern and a double bow, aptly described as shaped like a "boot-jack," had a Shreve snag-beam between the double-bows at the waterline, and handled snags with relative ease. To dispose of submerged wrecks, Merrill designed a huge, 1½-ton grapple which the *Woodruff* dropped onto wrecked vessels and dragged back and forth to tear them to pieces. First master of the *Woodruff* was Captain George Rowley, but its best-known master was Captain William H. Christian who commanded the vessel for about a quarter-century. The *Woodruff* operated on the Ohio for as long as a separate project for open-channel improvement existed. In 1925, after fifty years service, it was sold to the Greene Line, which used it as a wharfboat at Louisville until 1940.[7]

Colonel Merrill also put the steam dredge *Ohio* into operation in 1872 and the dredge *Oswego* in 1874. They were operated at costs considerably less than previous contract work. Each was eventually given an iron hull, and, like the *Woodruff*, became fixtures on the river. The *Ohio* operated until 1950, almost eighty years, and its hull was still in use in 1970. The *Oswego*, after a century of ser-



U. S. Snagboat E. A. Woodruff caught in ice jam, 1918

vice, was still dredging for a private company on the Monongahela River in 1970.[8]

Until the Ohio River Canalization Project was completed, the project for improving navigation with the methods developed by Captain Henry Shreve and Colonel Stephen Long continued. Though these methods frequently were of considerable benefit to light-draft vessels, their effects were seldom permanent and they could never have provided an adequate depth for heavily-laden barge traffic. New snags formed after every high water and the increased depth provided at a particular shoal by dike construction often resulted in decreased depths on downstream bars where dislodged materials again settled. Colonel Merrill summarized the problems attending open-channel improvements in 1879:

> It is always a disfficult and embarrassing matter to submit an estimate on a great river like the Ohio. All rivers contain a series of bars or shoal places over which less water can be carried than elsewhere, and the object of all works of river improvement is to add to the paying tonnage of river craft by increasing depths on these bars. On the Ohio there are two hundred well-defined bars, and many others with which navigators do not now concern themselves, but which will become prominent in case the better known bars are deepened.[9]

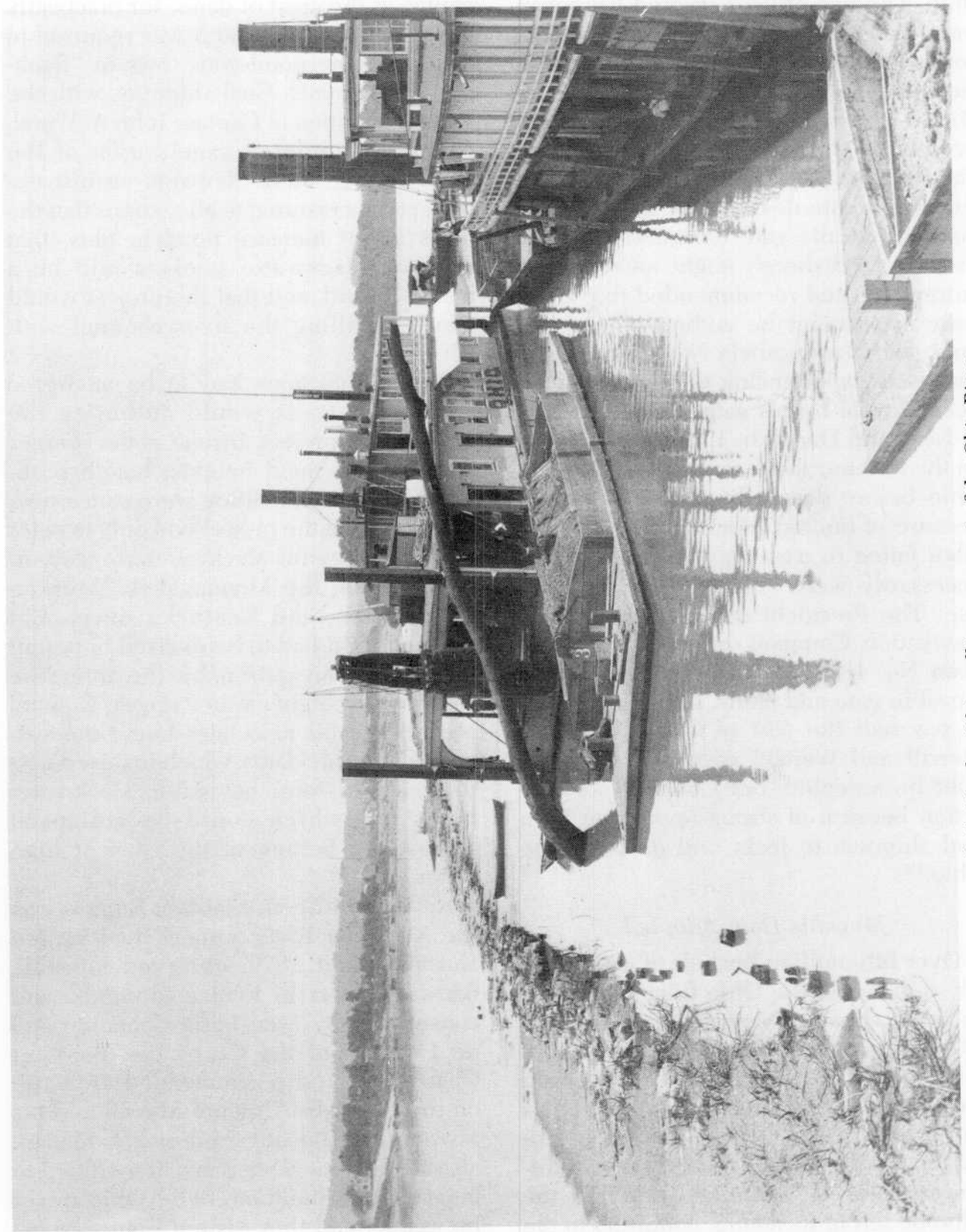
Slackwater Project Planning

W. Milnor Roberts commented in 1870 that the open-channel project on the Ohio, "although it will be productive of public benefit more than commensurate with the outlay required, it will be no more than an amelioration of the present difficulty." He declared that only construction of a canalization, lock and dam project on the Ohio could effectively meet hydraulic exigencies and navigation requirements. He recommended a slackwater project to secure a six-foot minimum navigable depth from Pittsburgh to Cairo, involving the construction of sixty-six locks and dams at estimated costs of $23,777,662. The Roberts plan was to construct a low fixed dam across the river at sixty-six locations. To pass traffic, each dam would have two locks (maximum chamber dimensions of 370 by 80 feet) and a 300-foot wide chute, closed with movable "shutters" at low water, in the crest of each dam. The "great desideratum" for the Ohio River, he asserted, was a constant, reliable navigation. But he predicted:

> Objections will be made to the adoption of any plan, some of which objections may be well founded; because it is hardly to be supposed that either plan, in its construction, will not injuriously affect, more or less, some private interest, private views, and present private arrangements. No great scheme designed for general public benefit ever yet escaped objections of some sort.[10]

Concerted efforts were undertaken by state governments after the Roberts report to gain congressional support for a canalization project on the Ohio. The legislature of Kentucky, for instance, on February 9, 1872, instructed the Kentucky congressional delegation to support canalization of the Ohio, and Kentucky joined with Pennsylvania, Indiana, Ohio, West Virginia, Illinois, and Tennessee in participation in the regional Board of Commissioners for the Improvement of the Ohio River (Ohio River Commission). Members of the Commission studied the economic and transportation situation on the Ohio Valley, met with Colonel William E. Merrill and other Army Engineers to learn the details of the proposed slackwater project, and actively lobbied for the project in Washington.[11]

Colonel William E. Merrill of Cincinnati District and General Godfrey Wetzel of Louisville District were appointed on April 16, 1872, as a special Board of En-



U. S. Dredge Ohio pulling a snag out of the Ohio River

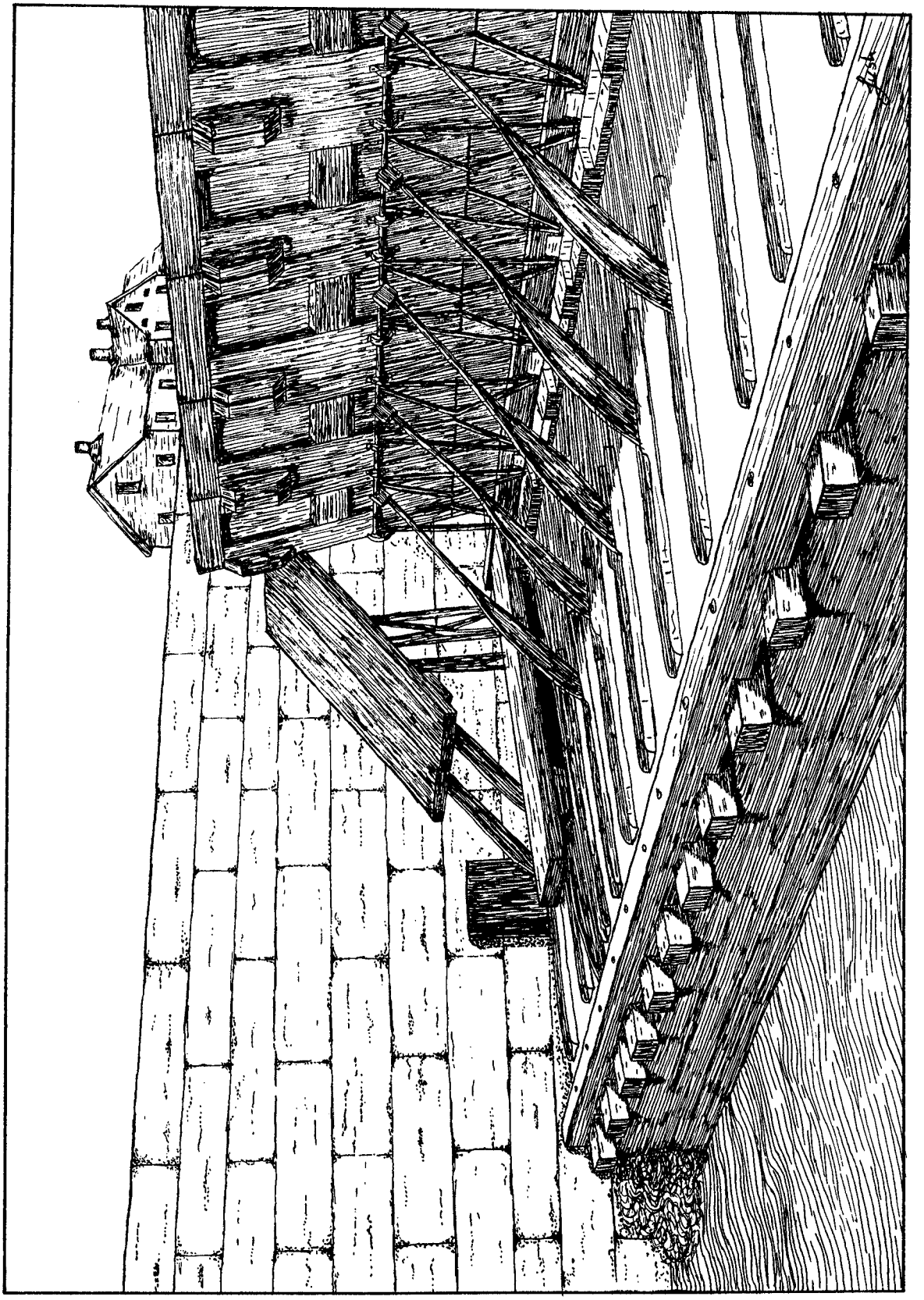
gineers to report on canalization of the Ohio. The two officers studied European waterways engineering, solicited proposals for movable gate designs for use in the chutes for coal-tows recommended by Milnor Roberts, and set up their own experimental station to test models of hydraulic gates. After experiments with a number of gate devices, the Board found that a hydraulic gate designed by F. R. Brunot of Pittsburgh might meet the requirements and recommended that a full scale experiment be authorized. At that time, the Monongahela Navigation Company was experiencing difficulties; huge fleets of coal barges gathered in the pool of Lock and Dam No. 1, a fixed structure on the Monongahela, to await a rise in the Ohio before descending to market, and because of limited lock capacity the tows often failed to pass the lock in time and necessarily were delayed until the next rise. The President of the Monongahela Navigation Company offered the use of Dam No. 1 for the experiment with the movable gate and chute, and also offered to pay half the cost of the experiment. Merrill and Weitzel suggested that this offer be accepted, but Congress took no action because of strong opposition from coal shippers to locks and dams on the Ohio.[12]

Movable Dam Adopted

Over fifty million bushels of coal annually descended the Ohio from Pittsburgh on "coal rises" of seven foot or more in 1874. It was transported in fleets of èight to twenty barges bound tautly to a steam towboat by a complex system of cables and chains. Delays ensued anytime separation and reassembly of tows was required, and coal shippers preferred the Ohio be left in its natural condition to the delays attending lockage. Nor were they pleased with the plans for gate-controlled chutes in the crest of dams, for practically the entire channel width was required to maneuver the ponderous tows in "flanking" movements. Coal shippers, with the single exception of Captain John A. Wood, vigorously opposed canalization of the Ohio, and in their campaign against the project they resorted to allegations that the dams might increase flood heights, that stagnant slackwater pools would be a health hazard, and that the project would result in filling the river channel with silt.[13]

These objections had to be answered before Congress would authorize the canalization project. Insofar as the charges of increased flood heights, health problems and channel silting were concerned, proponents of the project had only to point to the successful slackwater projects in operation on the Monongahela, Muskingum, Green, and Kentucky rivers. But some method had to be devised to permit open-river navigation by the immense coal tows at higher water stages. Colonel Merrill and his associates found the answer in movable dams, which in raised position would form navigable slackwater pools but which could be collapsed against the bottom of the river at high water.

Addison M. Scott, Assistant Engineer on the Kanawha River project, had visited Europe about 1870, observed movable dams on rivers in France (designed and constructed by Monsieurs Chanoine and de Lagrené of the Corps des Ponts et Chausseés), and recommended their use on the Kanawha. Colonel Merrill and his assistant, Lieutenant Frederick A. Mahan. also thought movable dams, if modified to meet special conditions of the Ohio, might be usable, and they visited France to examine the projects on the Seine, Yonne,



Chanoine Wickets at Davis Island Dam—Ohio River

Marne, and Meuse, and studied French engineering journals, while General Weitzel reviewed German waterways engineering. In 1874, Colonel Merrill recommended that movable dams, utilizing Chanoine wickets, be adopted for canalization of the Ohio.[14]

The Chanoine wicket, invented by Jacques Chanoine in 1852, made a movable dam possible. Chanoine wickets hinged to a concrete foundation on the bottom of the river, were aptly described as resembling large folding boards, about three feet, nine-inches wide and twelve feet long; eventually, on the Lower Ohio, much longer wickets were developed to increase slackwater pool depths and reduce the number of dams necessary for the project. To the back of each board was attached a metal framework, called a "horse," with a metal prop to hold the wicket in an upright position.[15]

At high water levels, the wickets lay flat on their foundation on the riverbed and opened the channel for navigation; when the river level dropped, a crew of men on a special maneuver boat hooked a grapple and cable to the top of a wicket and raised it, pulling the prop behind it along a groove in the foundation known as a Pasqueau hurter. When the wicket was released, water pressure forced it back and the prop slid down the hurter, or groove, to catch in a niche and hold the wicket upright. The maneuver boat then moved to the next wicket, repeated the process, and so on across the channel until all wickets were up to form a dam and provide a slackwater pool. At extreme low water the three-inch spaces between each two wickets were closed with pieces of wood, called "needles."[16]

Colonel Merrill recommended movable Chanoine dams in 1874 because they would meet the needs of coal-towing interests for open-channel navigation and at the same time provide slackwater pools at low-water. He also recommended that locks be 75 feet wide and 630 feet long to pass ten barges, a tow-boat, and a fuel flat at a single lockage. Swinging mitering lock-gates, hanging from supports on lock walls, could not, in the opinion of Colonel Merrill, be effectively operated in a lock wider than 75 feet. But coal shippers protested that 75 feet was still too narrow for the ordinary tow, without breaking and reassembling the barges before entering the lock, and Merrill subsequently designed a new type of lock-gate — a rolling gate mounted on wheels which rolled on tracks from one side of the lock to the other — to permit increasing lock width to 110 feet. He and a Board of Engineers then recommended that a 110- by 600-foot lock and movable dam be constructed at Davis Island, five miles below Pittsburgh, as an experiment to test the effectiveness of the plan and provide an improved harbor for the "Steel City."[17]

Politics and Authorization

Coal shippers denounced the project as a "damnable move," organized torch-light processions and similar demonstrations against it, warned the public that the project would cause pestilence, and would be ruinous to the coal trade and related industries. Colonel Merrill responded that coal-barging then constituted only about five percent of the value of the total commerce on the Ohio and should not hold up a project to benefit all commerce; pointed out that modifications had been made to meet the requirements of coal shippers; and declared that canalization of the river would facilitate a constant coal supply to consumers, preventing alternate coal-gluts and coal-famines. He asserted:

> The advantage to consumers would be incalculable. At present there is not a large manufacturing establishment on or near the Ohio and Mississippi Rivers that is not compelled to keep on hand at all times a large stock of coal for which it has no immediate use, but which it must retain for fear of low water and a consequent coal-famine, although it is well known that coal rapidly deteriorates when exposed to the weather. The advantage of being able to buy the barge-load coal fresh from the mine, in quantity as needed, would be worth millions to the industry of the Ohio Valley.[18]

But the coal shippers were not to be mollified; they pressured members of Congress to oppose appropriations for the project and opposed granting the necessary jurisdiction over the Davis Island site to the United States in the Pennsylvania legislature. But the project also had influential support from the Ohio River Commission and, indirectly, from the Grange, a national farm organization which wanted cheaper transportation and supported waterways for that purpose and as competition for rail lines.

The Senate Committee on Transportation-Routes to the Seaboard (commonly known as the Windom Committee) held hearings on the Ohio River Canalization Project in 1873 and 1874 as part of its broad review of transportation problems. The Committee, which was dominated by the influence of the Grange movement, heard testimony fron Colonel Merrill and Captain Milton B. Adams, deputy to General Weitzel. It reported that, though, railroads had been completed from the Ohio Valley to the Gulf, the waterways were still the "cheapest line of transport" and the competition of waterborne commerce forced the reduction of railfreight rates. Along with a number of other waterways projects, in 1874 the Committee recommended congressional authorization of the Ohio River Canalization Project, commenting in its report:

> The improvement of the Ohio River in such a manner as to secure from Pittsburgh to Cairo a depth of 6 feet of water at all seasons is believed by the committee to be one of the most important works for which the National Government can appropriate money.[19]

Congress appropriated $100,000 for land acquisition and initial construction of the experimental movable dam and lock at Davis Island in 1875. Colonel Merrill could not commence construction, however, until jurisdiction over the site had been granted by Pennsylvania and opposition of the coal men to the project prevented the enactment of such legislation for several years. The Pennsylvania assembly passed the jurisdiction bill in 1874, but it was vetoed by the Governor. It passed the lower house again in 1875 and was sent to the state senate, where it mysteriously disappeared and the legislature adjourned without acting upon it. In 1876 the coal interests arranged its defeat, but the Pittsburgh Chamber of Commerce, which wanted an improved harbor, took special interest in the legislation in 1877 and it was enacted.[20]

Davis Island Project: The Pattern

Construction of the Davis Island project commenced in 1878 and was completed in 1885; seven years were required because of limited funding and the experimental character of the work. The cofferdams used at the project were wooden frame boxes filled with loam excavated on Davis Island; a concrete foundation for the dam was poured and a timber framework embedded in the concrete to which the wickets and other appliances were bolted; lock walls and piers were built of ashlar masonry laid in Louisville hydraulic cement. And great care was taken to maintain minute records of costs and various construction methods to establish a fund

of engineering information for future projects. For example, in designing the chain and drum apparatus to be used in operating the lock-gates, Colonel Merrill consulted a number of authorities, including Commander George Dewy, U.S. Navy, who had considerable experience with a similar device for weighing ship anchors.[21]

The 110-foot wide and 600-foot long lock was, when completed, the largest lock in the world, and was not exceeded in width by even the ship locks of the Panama Canal. As previously mentioned, the rolling lock-gates were an original design of Colonel Merrill to compensate for the great width of the lock chamber. They were essentially Howe trusses built of pine timbers and mounted on metal axles and wheels. Each 117-foot long lock-gate was housed in a recess in the landward lock-wall when not in use; to close the lock, the gates were pulled across the lock on tracks set in the foundation by chains winding on drums powered by steam engines and water turbine wheels.[22]

The movable dam, also the largest in the world at the date of completion, totaled 1,223 feet long; it actually was 305 little dams — the number of Chanoine wickets in the navigable pass and three weirs. The 559-foot wide navigable pass was, as the name implies, the place where the wickets were lowered for navigation to pass across the dam when the river was high. The three weirs, also, constructed of Chanoine wickets on a concrete foundation, were raised and lowered to regulate the level of the pool above the dam. Wickets in the navigable pass were raised and lowered by a maneuver boat; wickets in the weirs were operated from a collapsible service bridge installed just upstream of the wickets.[23]

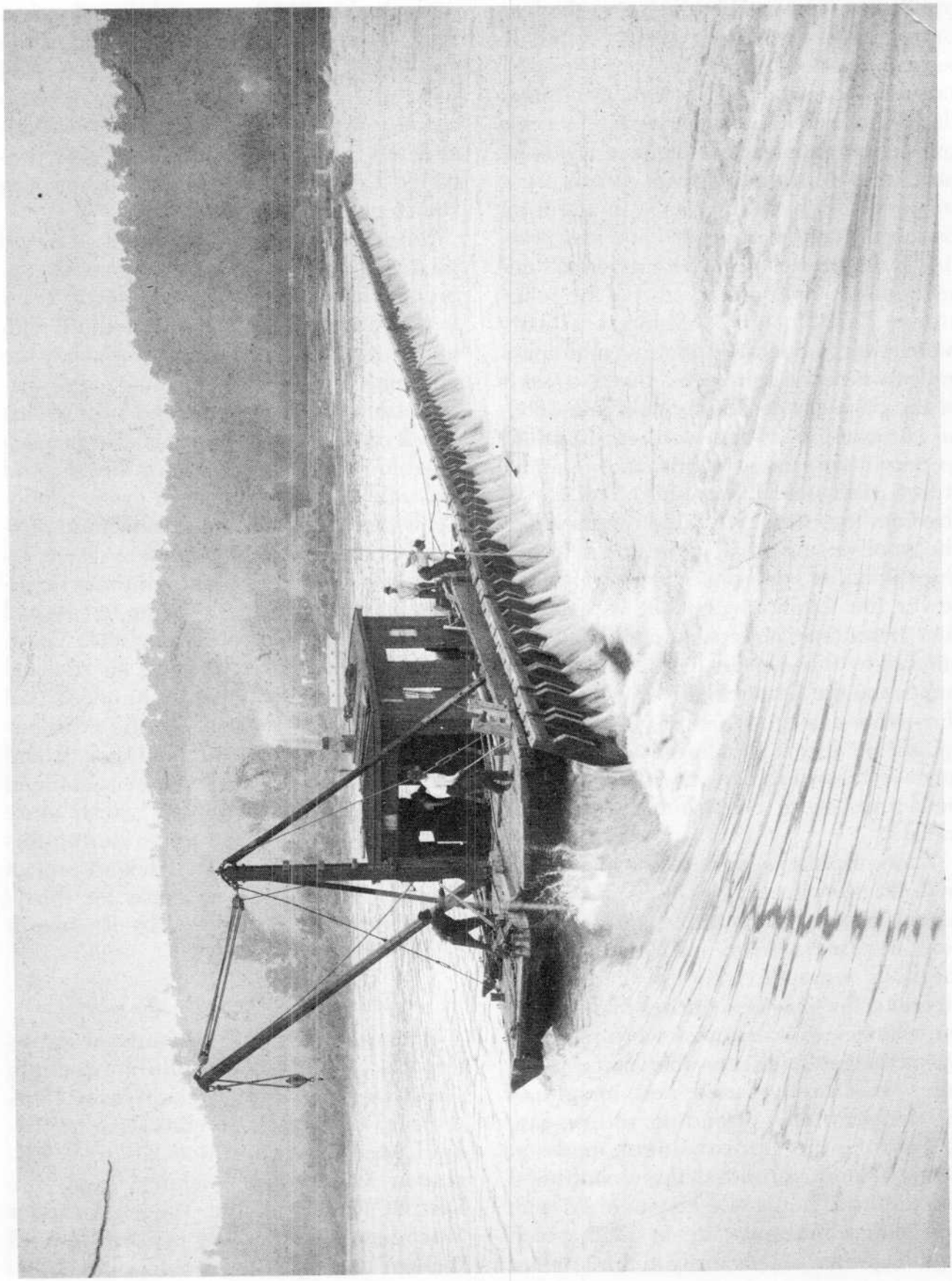
On October 7, 1885, an elaborate ceremony was held to open the $910,000 Davis Island project to navigation. A procession of thirty-nine steamboats crowded with congressmen and prominent citizens of Pittsburgh and other Ohio River ports steamed down river to the lock, to the cheers of a crowd along the banks, estimated to number as high as 50,000, and to booming cannon salutes. The occasion was marred, as such ceremonies often are, by accidents. A cannon firing salutes fired prematurely, blowing off the hands of the rammer and seriously injuring several spectators, and when the fleet arrived at the lock a problem had developed with operation of the lower lock-gate. Boats entered the lock and it was emptied and filled, but they could not pass through. The last orator of the occasion was Colonel William E. Merrill. He expressed his appreciation to all who had supported the project, and said:

> Let us hope that this celebration is but the forerunner of many similar ones until our beautiful river becomes the permanent home of a steady and beneficial commerce, and the ancient slur that it is "dry all summer" fades away into oblivion.[24]

At precisely noon, the Colonel's son raised the flag of the United States over the project, signaling the opening of navigation. As the colors billowed, Colonel Merrill proclaimed: "In the name of the United States, I now declare the Davis Island Lock and Dam to be open to navigation. *Esto perpetua.*" On the following day the locks were in order and the first boat passed through. It was, perhaps appropriately, a little market boat burdened with Ohio Valley produce.[25]

Davis Island Project: Operation

Colonel Merrill wisely recommended holding construction of further locks and dams on the Ohio in abeyance until ex-



Ohio River—Wicket raising operation

perience was gained in operating the first project. And there were several valuable lessons learned by the Corps at Davis Island which influenced the design of down-river locks and dams. The service bridge for operating the weirs at Davis Island was eliminated from subsequent projects because it was damaged by barges on several occasions and was practically destroyed by the debris which descended the river on the crest of the Johnstown Flood of 1889. Maneuver boats were used to operate both navigable pass and weirs on later projects. Also as a result of the damages caused by debris in 1889, an automatic bear-trap weir was installed to permit passage of debris. In operation, it was discovered that controlled use of the bear-trap weir facilitated regulation of the pool during small rises and reduced the amount of labor necessary to raise and lower the Chanoine wicket weirs. The first bear-trap was constructed of wood, similar to those used in the Beattyville project on the Kentucky River in 1884, but they were damaged in 1891 when a stable caught on fire at Pittsburgh and burning hay was thrown into the river. Subsequent bear-traps were constructed chiefly of metal.[26]

Many problems were also experienced with the novel rolling-gates. Axles broke, wheels broke, chains broke, and the lock-gate recesses filled with silt. Better methods were devised for sealing and cleaning the recesses during high water; the original wooden gates were replaced by metal gates; all movable parts of the gates were strengthened; and, in spite of all the problems attending rolling-gate operation, the improvement made at Davis Island permitted their continued use until the Louisville Engineer District designed a mitering-gate in 1916 which would operate satisfactorily in the 110-foot wide locks. Another problem solved at Davis Island was scour, or erosion of the riverbed, below the dam. Barges loaded with rock were sunk below the dam to remedy the problem and each dam constructed on the Ohio thereafter was protected by the placement of heavy riprap stones on the downstream side.[27]

Successful operation of the Davis Island project quickly quelled all previous apprehensions. The greater depth of water in the Pittsburgh harbor was credited with improving public health by reducing the problems attending the disposal of sewerage effluents. Increased water supply during dry summer months was also of inestimable value to riverside industry. And the coal shippers became great proponents of extension of the canalization project, because the pool formed by Davis Island Dam provided plenty of room for arranging tows and the traffic no longer had to await a river rise behind Lock No. 1, Monongahela River. During an unusual flood in July, 1888, about a hundred coal barges were wrecked on the Monongahela, but not one in the Davis Island pool went down; coal shippers claimed the project saved property worth more than the costs of construction during this single incident. The Davis Island project served Ohio River commerce for thirty-seven years, until replaced by Emsworth Lock and Dam in 1922.[28]

The Six-Foot Project, 1885-1910

Congress authorized a study of an extension of the six-foot minimum-depth slackwater project down the river in 1888. A Board of Engineers, consisting of Colonel Merrill, Cincinnati District Engineer; Major Amos Stickney, Louisville District Engineer; and Major Alexander Mackenzie, former deputy to General Weitzel at Louisville, held public hear-

ings which revealed the coal and navigation interests unanimously favored the construction of more locks and dams. The Board reported favorably on establishing a six-foot channel depth from Davis Island to just below the mouth of the Beaver River.[29]

Lock and Dam No. 6, named Merrill Dam in honor of the "Father of the Ohio River Improvement," was the second of the series constructed. The first appropriation for Merrill Dam was made in 1890, but funding was slow and the project was not completed until 1904. The first appropriation for Locks and Dams Nos. 2, 3, 4, and 5 was not made until 1896, and then only after navigation and commercial interests in the Ohio Valley had organized the Ohio Valley Improvement Association (OVIA) in 1895 to remedy congressional "neglect" of the river. In 1896 the OVIA took the House Rivers and Harbors Committee on a grand tour of the Upper Ohio River, its coal mines, and other industry to provide the congressmen with a first-hand knowledge of the needs of Ohio Valley commerce.[30]

Citizens of the Ohio Valley below the authorized canalization project became eager for extension of the project to river sections serving their localities. In 1899 canalization of the river to Marietta, Ohio, at the mouth of the Muskingum River was authorized, bringing the number of approved locks and dams to eighteen. Funds were first provided for Locks and Dams Nos. 13 and 18 of the additional structures to furnish harbors for the port cities of Wheeling and Marietta. In 1902 canalization of the Ohio to the mouth of the Miami River, just below Cincinnati on the Ohio-Indiana state line was approved; the Corps recommended that locks and dams be first constructed below the port cities of Cincinnati, Point Pleasant, Gallipolis, Parkersburg, Catlettsburg, and Portsmouth, in that order, and, as a result, the first lock and dam of the series to be constructed in the present Louisville Engineer District was No. 37 below Cincinnati.[31]

Construction of a lock and dam below Evansville and Henderson to provide a harbor for those ports and to aid traffic from the Green River was studied, and this study plainly indicated that a decision on the advisability of completing the slackwater project throughout the length of the Ohio River was in order. General Alexander Mackenzie, Chief of Engineers, observed that two locks and dams (Nos. 1 and 6) were completed, seven were under construction in 1904, and five more were funded. To construct a lock and dam below Henderson (No. 48) would commit the United States to completing the canalization of the river at least that far. In the opinion of the Chief of Engineers, a full-scale review of the project was required before additional commitments were made.[32]

There was another problem which had been raised on the upper river. Major William L. "Goliath" Sibert, who had begun his civil works career on the Green River project and served as Louisville District Engineer, 1900-1901, directed construction of Locks and Dams Nos. 2-6 as Pittsburgh District Engineer. Studies indicated that the six-foot project, though satisfactory for the dwindling steamboat packet trade, was inadequate for the deep-draft barge-towing system, and Major Sibert recommended raising the first six dams to provide a nine-foot channel. The nine-foot depth for the first dams of the series was approved by Congress in 1905.[33]

Thus, by 1905, three problems had to be resolved before the Ohio River Canaliza-

tion Project was continued. First, should the project be extended to the Lower Ohio River, or could the commerce of the lower river be adequately served by a continued open-channel improvement project; second, what might be the relative costs and benefits of a nine-foot navigable depth as compared with a six-foot project; and third, with commerce on the Ohio, and on the inland rivers in general, declining, would continuation of the canalization project be economically justified?

The Lockwood Board

To review these questions, Congress directed the appointment of a Board of Engineer officers in 1905. This Board, called the "Lockwood Board" because its senior member was Colonel Daniel W. Lockwood, had all Ohio River District Engineers as members. It conducted its broad review of the canalization project in 1905 and 1906, touring the river aboard the *Major Mackenzie* to view actual conditions and holding hearings at Pittsburgh, Cincinnati, and Louisville. Typical of the testimony presented to the Board was that of the Louisville Board of Trade:

> With a deep and uninterrupted river the number of steamboats and barges would multiply one hundred fold. The cost of a steamboat is large and people will not at present invest money to a great extent in a property that can work only one-half the time. With open river the year round the boats and barges would quickly come and shippers would patronize them, for contracts could be made for future deliveries with a knowledge that the river would be open and delivery made. With deep water and uninterrupted navigation from Pittsburgh to New Orleans and the opening of the Panama Canal Louisville and the whole Ohio Valley can send the products of their factories and fields into good foreign markets.[34]

At the time of the Lockwood Board investigations it was evident that waterborne commerce on inland rivers was declining; on the Ohio the steamboat packet trade was experiencing serious losses, though the growing coal trade kept actual tonnage at a high level. The general decline on waterways was attributed to many causes: to railroad competition and deliberate efforts by railroad management to destroy its waterways competition, to inefficient management of the steamboat business, and to way charges collected at port cities for wharfage. The Lockwood Board concluded, however, that the cause of the proportional decrease in waterborne commerce was the "unreliability" of navigation on unimproved streams. Its studies indicated the commercial and natural resources of the Ohio Valley were sufficient to require reliable waterways service in addition to railroad facilities. It also found that the completed project section on the Upper Ohio had stimulated a "remarkable" industrial development at riverside, and it predicted that similar development might be expected on downstream sections were the river canalized.[35]

National waterways policies were in transition at the time the Lockwood Board conducted its studies. There was growing public concern about the "decadence" of American waterways, as compared with the high level of development and utilization of European rivers. This concern was partly expressed by the organization of the National Rivers and Harbors Congress in 1901 to promote waterways projects and the increased activities of the Ohio Valley Improvement Association.

The OVIA, for example, in 1905 arranged a tour of the Ohio Valley by the House Committee on Rivers and Harbors and the Lockwood Board of Engineers. The group was assured by Louisville newspapers, on their arrival at the Falls City on May 15, that the motto in the Valley was: "Dredge and dam the Ohio river

so as to insure a nine foot stage of water the year round." The group was addressed that evening by Will S. Hays, the seventy-year-old balladeer and river reporter, who told them:

> God Almighty gave you the Ohio river, and if you fellows can't raise enough money at Washington to improve what God Almighty gave you, you are a poor lot. I hope and I feel sure that Congressmen will open their hearts and give the Ohio River what it needs. I trust that no one of you will have a grandson who will look upon the Ohio and say that it may be locked, but it isn't worth a dam.[36]

The Kentucky legislature expressed its support for the canalization project in 1906, pointing out that federal appropriations for waterways projects had averaged less than twenty million dollars annually during the previous decade and were "wholly incommensurate with the great interests involved." The legislature resolved that Congress adopt a "broad and liberal" policy of providing fifty million dollars for water ways annually and instructed the congressmen from Kentucky to support such a policy.[37]

Reform of "pork barrel" waterways policies was a dominant issue during the administrations of Presidents Theodore Roosevelt and William H. Taft, 1901-1913. Hundreds of protests against "pork barrel" policies were printed in the newspapers and journals of the era. For example, the editor of *Engineering News*, an influential professional journal, wrote in 1909:

> It is the system that is radically at fault, rather than the men who have administered the system. The individual officer of the Corps of Engineers is powerless to effect a change and the individual Congressman is almost as helpless. The public has not in the past and does not to-day look to the Corps of Engineers to originate or recommend plans for waterways improvement. It does not even welcome the advice of these engineers in reporting upon offered projects. Each city and district wants to boom the waterway schemes in its own locality; and many an engineer officer has made himself unpopular because he could not as an engineer approve some of the schemes brought forward in the district.
>
> The root of the difficulty with our internal waterway development of the past is that it has been a matter of haphazard growth. The engineer has seldom had a chance to plan on broad lines and when he has made plans there has been no assurance that the plans would be carried out before the whole work became obsolete.[38]

The first step toward reforming "pork barrel" policies was taken in 1902; the Corps created the Board of Engineers for Rivers and Harbors, a national board to review all projects independent of any local political influences. Under the reform leadership of Chairman Theodore H. Burton, the House Rivers and Harbors Committee adopted the policy in 1907 of declining consideration of any project which did not have the prior approval of the Corps of Engineers. And the Inland Waterways Commission, created by President Roosevelt in 1907, was the first of several executive committees which investigated and recommended sweeping revisions in waterways systems policies.[39]

In this atmosphere of growing concern with diminishing use of inland waterways and reform in national waterways policies, the Lockwood Board completed its investigation of the Ohio River Canalization Project. On December 15, 1906, the Board reported that a project to establish six-foot navigation from Pittsburgh to Cairo would cost $50,962,266, as compared with a cost of $63,731,488 for a 54 lock and dam system to provide nine-foot navigation. It estimated the probable cost per ton-mile for a six-foot project would be .0653 cents and for a nine-foot project would be .0447. The nine-foot project showed an estimated economic advantage in the ratio of 3 to 2, while construction costs would be greater in a 6 to 5 ratio. The Board therefore recommended adoption of a nine-foot

project for the entire course of the Ohio, the principal thrust of project rationalization being:

> Having in view the fact that a canalized river offers an upstream navigation lower in cost and quicker in transit than an open-river project, the Board, arguing from the known natural resources of the section and its population, concluded that a river improved by this method will afford facilities for the cheap exchange of mineral, agricultural, and manufactured commodities, which from their low value and bulk cannot be exchanged unless such cheap facilities are offered, and that there is every probability that the improvement of the Ohio River by canalization, as proposed, would induce a very large future commerce which does not now exist in addition to retaining and greatly facilitating and cheapening the commerce which the river now bears.[40]

The Board of Engineers for Rivers and Harbors made a personal inspection of the river, held additional public hearings, restudied the recommendations, and concurred with the Lockwood Board report. It concluded that, though the Ohio River project was "on a scale not hitherto attempted in this country," the Ohio River was the one river above all others "most likely to justify such work."[41]

The Chief of Engineers pointed out the project was based upon a "conjectural future commerce" of thirteen million tons annually. Though the Lockwood Board was convinced that the probability of increased traffic was sufficiently strong to justify the large expenditures for the proposed project, Congress had not previously sanctioned a project of similar scope, and the Chief of Engineers preferred not to recommend the project, and to leave it to the "wisdom of Congress."[42]

And there were those who questioned the project rationalization based on projected future commerce. The editors of *Engineering News*, for example, stated that the Ohio River Canalization Project was "bound to be a losing one." President William H. Taft, however, threw his support to the project, commenting:

> It seems to me that in the development of our inland waterways it would be wise to begin with this particular project and carry it through as rapidly as may be.[43]

Congress authorized construction of a nine-foot slackwater project on the Ohio to its mouth, as recommended by the Lockwood Board, in the Rivers and Harbors Act of June 25, 1910. Its determination to avoid the pitfalls of previous "pork barrel" policies was indicated by the stated intention to furnish funds at a rate sufficient to complete the project in twelve years; that is, by 1922. Nevertheless, the first appropriation for land acquisition and initial construction for a project estimated to cost over $63,000,000 was only slightly more than one million dollars; unless the amounts provided in subsequent legislation were substantially greater, it was evident that the twelve-year deadline could not be met.[44]

Summary

Though the Army Engineers on the Ohio made several advances in floating plant design and engineering methods, the open-river channel improvement project on the Ohio could only lengthen navigation for a few months each year. Open-river improvements could never have provided a dependable depth for year-round navigation. Immediately after the Civil War, the Corps initiated studies of other improvement methods and selected the slackwater, lock and movable-dam method as the one most likely to meet commercial requirements and hydrologic conditions on the Ohio. Under the direction of Colonel William E. Merrill, the "Father of the Ohio River Improvement," an experimental lock and movable dam was completed just below

Pittsburgh in 1885, and its successful operation convinced the skeptical of its value and led to increased support for extension of the slackwater project to provide reliable navigation on the entire length of the Ohio.

Studies completed at the turn of the century indicated that a nine-foot navigable depth, instead of the six-foot depth provided by original structures, would be more serviceable and economical for the deep-draft barge-tows handling low-value bulky commodities on the waterways. And in 1905 comprehensive studies of existing and potential commerce on the Ohio, the feasibility of canalizing the entire river, and the comparative advantages of six- and nine-foot projects commenced.

These studies came at a time when the steamboat packet business in the inland rivers was entering its final phase, when commerce on inland waterways was proportionally diminishing, and when federal waterways policies were being reconsidered. The Lockwood Board predicted that canalization of the Ohio to a nine-foot navigable depth would provide dependable navigation for the movement of bulky industrial materials, would stimulate industrial development in the region, and would thereby lead to a revitalized commerce on the river. A number of skeptics did not agree, arguing that construction of the Ohio River Canalization Project would never provide benefits commensurate with costs. But Congress authorized the nine-foot project on the Ohio in 1910. It was commonly agreed that the Ohio River Canalization Project would be the test; that its improvement had more potential for success than any other in the nation; and if it did not succeed then federal improvement of waterways for navigation should, for the most part, be abandoned.